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14. ABSTRACT

The research was initially based on the idea of applying model based testing. An experiment was carried out which involved cell phones. Based on experiences with this, and other observations, it was determined that a priori models were unlikely to be available. A new approach was investigated. It resulted in the development of a new kind of model generation and coverage tool called MOCCA (model oriented coverage and analysis) together with a new kind of supporting behavior model.

15. SUBJECT TERMS

models, testing, process algebra, behavior, states

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ONR Final Report

Introduction
The general area of research that was investigated was model based testing. In this approach, a model of the software is used to generate tests and measure test completeness. The general idea is that if all transitions in a state model are traversed in at least one test, then the functionality of the system that is characterized by the model has been exercised.

Research Plan
The original plan was to investigate the use of model based testing for cell phones. In a preliminary study, state models were constructed for the Nokia 5185i cell phone and used to carry out functional testing. This resulted in the discovery of 3 significant functional errors.

One of the problems with the model-based approach is that models are seldom available, and it is unrealistic to expect to use a methodology that depends on the *a priori* development of a model based specification. Instead we investigated an alternative approach in which (partial) models are derived while a set of tests is being carried out. Such models fulfill the following functions:
>   1) They summarize the testing that has been carried out so far
>   2) They serve as a test-based specification, as in Extreme Programming
>   3) They provide a basis for suggesting additional kinds of tests that
>   should be carried out, based on what is known about the software so far

Prototype MOCCA Tool
A prototype tool was built that uses the capture-playback traces generated by Rational Robot. MOCCA (Model Oriented Capture Coverage Analysis) constructs a model from the traces, which it presents to the user, fufilling the functionality suggested above in 2 and 3. MOCCA also contains 3 test wizards that use this model, plus other information that is available to it, to suggest additional tests to the user. The user then carries out these tests which may result in additional information being added to the model.

MOCCA has a number of more elaborate features, such as: the ability to represent the system under test at 3 different levels of abstraction, and the ability to "prime" a new test with part of an old test - relieving the user of the need to repeat initial parts of a new test that are the same as an old test.

MOCCA Theoretical Foundations
In order to use MOCCA effectively it is necessary to know when a testing effort can stop. In the MOCCA paradigm this is accomplished using *bounding* and *induction*. Bounding is accomplished by a wizard that determines a kind of "upper bound" on a model. This describes possible additional test cases that have not been carried our, and are hence not yet included in the derived model. Induction characterizes the situations in which a testing direction can be halted because it will provide no information that is different from what has already been explored. It is based on a new approach to behavior

description that is derived from process algebra. The key new idea is the concept of *context sensitive behavior*, in which an agent may exhibit different kinds of behavior depending on the contexts in which it occurs. Termination of a testing direction is valid when behavior is context free.

Continuing MOCCA Research

Research is proceeding in several areas. Some additional work is being done on the MOCCA tool, and planning is underway to apply the new technology to additional areas of application. The original MOCCA tool was built for GUI based Java programs. New tools, and their supporting theoretical foundations, are being developed for Web based and distributed applications

Research Papers and Publications

An unpublished report was written on the cell phone experiment. The MOCCA work has not been published. A report on the original MOCCA tool and its theoretical foundations is current being written and will be finished in approximately six weeks.

Funding

The MOCCA project currently has no funding. The ONR funding, which made the research possible, expired in December 2001. No additional funding has been applied for from any agency.

Graduate Students

Four masters graduate students have worked on the MOCCA project. Two are directly involved in the development of the MOCCA tool. The other 2 students investigated the feasibility of using different kinds of tool architectures for capture-playback tools, that would provide more flexibility than that offered by Rational Robot, which is the COTS tool currently used by MOCCA.